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PLAYBACK OF INTERACTIVE PROGRAMS

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## **BACKGROUND OF THE INVENTION**

### 1. Field of the Invention

5           The invention relates generally to broadcast television systems and more particularly to a system and method for playing back programs which have been stored on the storage device of an interactive television system receiver, wherein the programs contain one or more interactive applications.

### 10    2. Description of Related Art

Interactive television systems provide a means to deliver interactive content as well as ordinary television audio and video to a large number of subscribers. Programs broadcast by these systems may incorporate television audio and video, still images, text,  
15   interactive graphics and applications, and many other components. The interactive content of the interactive television signal may therefore include application code, data associated with the audio and video, control signals, raw data and many other types of information.

20           Interactive content such as application code or information relating to television programs is usually broadcast in a repeating format. In other words, each piece of information is broadcast a first time, then each is transmitted a second time, and so on. The cycle is repeated so that each piece of interactive data is transmitted, for example, every ten seconds. The pieces of information which are broadcast in this manner form  
25   what is referred to as a "carousel." The sequence of information that makes up the carousel can be prepared in advance, or it can be determined "on the fly."

Broadcast systems (e.g., interactive television systems) transmit information in a carousel format in order to allow receivers in the system to selectively obtain particular

pieces of information in the carousel without requiring a return path from the receivers to the server. If a particular receiver needs a particular piece of information, it can simply wait until next time that piece of information is broadcast to obtain the information. If the information were not cyclically broadcast, the receiver would have to transmit a request for the information to the server, thus requiring a return path. Other receivers in the system can operate in the same manner, each receiver waiting for the information it needs, and then using only that information. By employing carousels to broadcast information, the system eliminates the need to connect each of the receivers with the server and further eliminates the need for the server to process individual requests for information. Generally, a broadcast signal may include a number of programs which in turn may include a number of audio/video streams and/or data streams. Data streams may be used to carry data such as interactive application data, subtitle information, or other data.

The pieces of information, or data objects, in a carousel are often intended to be combined to form a single program. This program may also contain streaming data such as audio or video. For example, an interactive television game show may combine television audio and video with interactive content such as application code which allows users to answer questions. Another example would be a news program which combines audio and video with application code that inserts current stock prices in a banner at the bottom of the screen. It is to be understood that the term "program" as used herein refers to any broadcast material including television shows, sporting events, news programs, movies, or any other type of broadcast material, or segment of the show, event, program, movie, or other material. The program may include only audio, video, data, or any combination thereof. The program may be only a portion of a television show or broadcast (e.g., without commercials, or missing a portion of the beginning or end) or may be more than one show, or include commercials, for example.

Program content received in a broadcast system is normally intended to be consumed immediately. It is nevertheless possible to record this content for later playback. The broadcast information can be recorded "as is" (i.e., as the stream of data transmitted to the receiver,) or it may be recorded as a set of files that can be accessed randomly instead of sequentially. If the information is recorded as a data stream, the data may be referred to as "pushed" data since the receiver must play the information back as a data stream -- it cannot retrieve particular data objects out of order. Data objects which are recorded as a set of files can be individually retrieved, and may therefore be referred to as "pulled" data.

Regardless of whether an interactive program is stored as pushed content or pulled content, there may be difficulties in playing back the recorded program, since it was originally intended for immediate consumption. Although it may be a relatively simple matter to play back the entire program from start to finish, just as it was originally provided to a user, the user may wish to use a special mode, such as pausing, fast-forwarding, reversing, or jumping to particular points in the program when it is replayed. Because the program may include different interactive applications which are in various states throughout the program, it is necessary to maintain the proper states for these applications, even when parts of the program are skipped in special playback modes. Further, the applications may interact with other data objects, so in a special playback mode it may be necessary to generate signals that would not otherwise be generated.

### **SUMMARY OF THE INVENTION**

One or more of the problems outlined above may be solved by various embodiments of the invention. One embodiment comprises an interactive television receiver which is coupled to a storage device. The receiver is coupled to a broadcast network and configured to receive a signal corresponding to a program. The signal contains pushed interactive television data. The receiver is configured to store the pushed

data, either as pushed content or as pulled content, on the storage device. When the program is played back from the storage device, the receiver is configured to launch applications which are detected in the program. If the program is stored as a stream of data, an application may be detected by receiving an indication that it is available. If the program is stored as a set of files, an application may be detected by comparing the validity range of the application to a current playback index for the program. If special playback modes are used, the receiver is configured to determine whether the program would generate signals during the portion of the program skipped during special mode operations and to generate corresponding notifications if necessary. The receiver may also be configured to terminate and restart applications which are not configured to operate in special playback modes.

One embodiment comprises a method for playing back a program which includes one or more interactive applications. A program is stored, either in the form of a data stream or as a set of files containing the data objects which make up the program. When playback is started, applications which are detected are launched. Applications are detected in the playback of pushed content when they become available in the playback stream. Applications are detected in the playback of pulled content by comparing the validity ranges of the applications to a current playback index. When special playback modes are used, signals which affect the lifecycle of an application are detected and corresponding signals are generated to notify the application to allow it to maintain its proper state. During these special playback modes, these various notification signals may be conveyed to applications which are configured to operate during these modes. Applications which are not configured to operate during these special playback modes may be terminated when the special modes are initiated and restarted when the special modes end.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the accompanying drawings in which:

5           Fig. 1 is a functional block diagram of an interactive television system.

Fig. 2 is a diagram illustrating the structure of a carousel and a corresponding data stream.

10           Fig. 3 is a diagram illustrating the interrelation of data objects in one program.

Fig. 4 is a flow diagram illustrating one embodiment of the present method.

15           Fig. 5 is a flow diagram illustrating an embodiment of the present method in which a program has been stored in a data stream.

Fig. 6 is a flow diagram illustrating an embodiment of the present method in which a program has been stored as a set of files.

20           While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and  
25           alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Broadly speaking, the invention comprises an improved system and method for replaying stored interactive programs, wherein the programs are originally intended to be consumed as pushed broadcast data. While many embodiments of the invention are possible, the following description focuses primarily on one embodiment which is implemented in an interactive television system. This description is intended to be illustrative rather than limiting.

Referring to Fig. 1, a functional block diagram of an interactive television system 10 is shown. Interactive television system 10 generally comprises a broadcast station 12 and a receiving station 14 coupled to the broadcast station by a broadcast medium 13. In this figure, broadcast medium 13 is depicted as a satellite transmission network. The broadcast medium may, in other embodiments, comprise other transmission means such as cable, telco, MMDS (microwave) and terrestrial transmission media. Broadcast station 12 is coupled to a program source 15 which is configured to provide the data which forms the program. Receiving station 14 includes a receiver 18 which is coupled to a storage device 16. Storage device 16 is configured to store the program data. Receiving station 14 also includes a television 17 which is used to present the program to a user.

In one embodiment, the data objects of a program which is to be broadcast from broadcast station 12 to receiving station 14 are stored in one or more program sources 15. The data objects may be stored separately (e.g., as independently accessible files,) or they may be stored as a preconstructed data stream. It should be noted that the program may also contain streams of data (e.g., audio and video) which are not transmitted as data objects. If the data objects of the program are stored as individual files, they are retrieved by broadcast station 12 from program source 15 to be sequentially broadcast. If the program is stored as a preconstructed data stream, the stream can be broadcast essentially as it is stored. The program data may be compressed and control information may be

added to the data for use by the interactive television system. The program data and any additional information is then converted by broadcast station 12 to a format suitable for transmission over broadcast medium 13. In this particular embodiment, the data is formatted into packets which can be transmitted over a digital satellite network. These packets may be multiplexed with other packets for transmission.

Broadcast station 12 transmits the data objects of the program in a carousel which is cyclically transmitted to receiving station 14. This produces a stream of data in which each data object is transmitted repeatedly. It should be noted that the broadcast medium (a digital satellite network in this embodiment) can support a number of different channels, and that different carousels (and corresponding data streams) can be concurrently broadcast on these channels. When receiving station 14 receives the data stream, the program contained in the data stream may be played immediately or it may be recorded. If the program is to be played immediately, receiving station 14 converts the data stream back into the data objects and uses them as necessary in the program. If the program is to be stored, it may be parsed into the individual data objects and stored as a set of files, or it may be stored as a data stream, as it was received. If the program is to be stored, it is conveyed to storage device 16. Data streams which are included in the program (e.g., audio or video streams) may also be stored on storage device 16. The program may be stored whether it is immediately played or not.

Receiver 18 is typically implemented in a set-top box which is connected to television 17. The set-top box incorporates a control unit (e.g., a microprocessor,) a memory, and other components which are necessary to select and decode the received interactive television signals. Because the basic components and features of set-top boxes are known, they will not be discussed in detail here. Typically, set-top boxes are designed to provide the necessary interactive functionality at a minimal cost. Consequently, they normally have a limited amount of memory and no storage devices (e.g., hard disk drives.) While the memory is sufficient to execute interactive



applications, it is not adequate to store the applications for an indefinite period of time. Therefore, the applications do not normally remain in memory when they are no longer being executed.

5 Even if the memory of the set-top box were large enough to store some interactive applications, it might still be too small to accommodate a program which includes large amounts of audio or video data, application code, or other information. In one embodiment of the present system, storage device 16 is coupled to the set-top box to provide sufficient storage to record programs that will not fit in the limited amount of  
10 memory in the set-top box. Storage device 16 may comprise any suitable storage device, such as a hard disk drive, a recordable DVD drive or optical disk drive. It can be internal to the set-top box, or it may be connected externally. Storage device 16 can be connected permanently or removably to the set-top box.

15 Referring to Fig. 2, the structure of a carousel (and a corresponding data stream) which is transmitted to the receiver is illustrated. Carousel 24 comprises data objects 21-23 and carousel information 20. Data objects 21-23 are retrieved from a program source as described above. Carousel information 20 is provided by the broadcast station and may contain information such as the carousel ID and version number, a file access table  
20 or directory for the carousel, and various other information. (Portions of this information, such as the file access table, are not necessary in programs which are intended for immediate consumption.) The broadcast station transmits carousel information 20 and data objects 21-23 sequentially. The first instance of the transmission of carousel 24 is indicated by 25. After the broadcast station has completed transmission of the first  
25 instance of carousel 24, it is transmitted again, as indicated by 26. The successive, cyclical transmissions of carousel 24 indicated by 25-29 form data stream 30. Transmission of the carousel may be repeated indefinitely.

As mentioned above, the data objects which comprise a program may include application code, audio and video data, control signals, raw data and other types of information. If the program is to be immediately consumed (i.e., presented to the user,) the data must be parsed to extract the data objects from the stream. When the necessary data objects have been extracted, the program is played. The data objects are used as defined in the program. For example, any applications which need to be executed are launched, any audio or video data which needs to be presented to the user is played or displayed, any signals which need to be produced are generated, and so on. The program is presented to the user, typically via a television 17, and is consumed. Regardless of whether or not the program is immediately presented to the user, it can also be stored. The storage device can be used to store programs "as is" (i.e., as a data stream which is essentially the same as that received in the broadcast signal) or as a set of files that can be individually accessed or updated. In either case, the recorded program can be played back. The present system and method are employed to facilitate and/or enable the use of playback features such as trick play modes when viewing the recorded program. To illustrate the advantages of the system and method, it may be useful to examine the structure of a program.

As noted above, a program may consist of a number of data objects and data streams. These data objects may reference each other, they may trigger certain events, or they may be triggered by certain events. Interactive applications which are contained in the program may be started and stopped while the program is being played. If the data objects are stored as files, the validity ranges associated with the files correspond to the times during which they are available to the program. For example, as long as a data object is being broadcast as part of a carousel, that data object is valid. When the carousel (hence the data object) is no longer being broadcast, the data object is no longer valid. Thus, a start time and an end time defining the validity range of the data object can be determined by the receiver and stored with the corresponding file.

It should be noted that, although the present disclosure is directed primarily to an interactive television system which is configured to play back a previously stored broadcast program, the system and method presented herein are equally applicable to the playback of programs which are stored by other means. For example, pushed content  
5 which could be broadcast may also be stored offline (e.g., on a DVD) and later distributed to the user for playback. The program could also be played back from an on-demand server (e.g., playing video on demand.)

Referring to Fig. 4, a flow diagram illustrating one method employed by the  
10 interactive television system described above is shown. After the program is recorded on the storage device, playback of the program is initiated. The receiver is configured to detect applications in the recorded data. When an application is detected in the program, the application is launched. The manner in which applications are detected in the program depends upon how the program was stored.

Referring to Fig. 5, a flow diagram illustrating the detection of an application in a system configured to receive a program as a data stream is shown. If the application was recorded as a data stream, the receiver detects an application by examining the sequential stream of data which is played back from the storage device. When the stream contains  
20 information indicating that the application is available, the receiver detects this information and thereby detects the application. The application is then launched.

Referring to Fig. 6, a flow diagram illustrating the detection of an application in a system configured to receive a program as a set of files is shown. If the program was  
25 recorded as a set of files, the detection of applications in the program proceeds in a different manner. When playback of the program is initiated, the receiver examines the stored files. In one embodiment, the application files include information defining validity ranges for the corresponding applications. The receiver compares the validity range for each application to a current playback index. If the current playback index falls

within the validity range of a particular application, that application is considered to have been detected, and is launched.

5 The current playback index mentioned above is simply a relative time index used in the playback of the program. The validity ranges mentioned above comprise data which, in one embodiment, is determined by the receiver when the program is recorded. (It should be noted that in some embodiments, particularly those in which the program is played back from a prerecorded medium such as a DVD, the validity range may be predetermined and provided with the corresponding data object.) The validity range  
10 consists of a beginning time and an end time. The application is intended to be executed (or to be available for execution) between the beginning and end times. Thus, if playback of a program is initiated and the current playback index is within the validity range of an application, the receiver will launch the application.

15 This may be illustrated in the following example. Assume a program is broadcast from 1:00 to 2:00. The program contains an application which is valid during the entire program. If a user records the program from 1:30 to 2:30, the application is stored with a validity range from 1:30 to 2:00, or 30 minutes from the beginning of the recording. When the program is played back, the application will be valid for the first 30 minutes of  
20 the recording. If the user starts playback of the program and fast-forwards for 40 minutes, when normal playback is resumed, the application will no longer be valid and will not be restarted.

25 Whether the program was stored as a data stream or as a set of files, the detection of applications continues as the program is played back. Thus, as new applications are detected, they are launched. It should be noted that the capabilities of the receiver and the policies implemented in the execution environment of the receiver determine the effect on a currently executing application of launching another application. If the receiver is capable of executing only one application at a time, a currently executing application may

have to be killed or suspended before another application can be launched. It may or may not be necessary to unload the first application from memory while the second application is executing. If the receiver can simultaneously execute more than one application, then the second application may be launched while the first application continues to run. The receiver may, however, implement a policy which prohibits executing applications simultaneously. The receiver may therefore be required to kill or suspend the first application upon launching the second, even though the receiver is capable of executing both.

As mentioned above, when a user plays back a program, he or she may wish to use special playback modes rather than simply playing the program back sequentially (i.e., in a normal play mode.) The special modes may include trick play modes, such as fast forward, slow motion and rewind, and may also include jump, seek and pause features. When special play modes are used, the program moves from a first point at which an application is in a first state (e.g., executing) to a second point at which the application should be in a second state (e.g., terminated or suspended.) Because the portion of the program between the first and second points is not played (or executed,) certain signals and events which would normally cause an application to modify its state are not encountered. Care must therefore be taken to ensure that the lifecycle of the application resulting from use of the special play mode corresponds to the position in the program after the special play mode is stopped. ("Lifecycle" is used here to indicate the state of the application, including but not limited to states of execution, such as launch, suspend, resume and terminate, and any internal states defined by the application during execution.)

Because the application may skip an event (a signal or set of conditions) which should trigger a change of state in the application, it may be necessary to take some action to produce the change of state. In one embodiment, the receiver is configured to determine whether any events would occur between initiation of the special play mode

and termination of the special play mode which would affect the lifecycle of the application. These events may include the receipt of particular signals or notifications, the existence of particular conditions, or other factors. The receiver is configured to generate signals or notifications corresponding to the skipped events, and to convey these  
5 signals or notifications to the application to modify its state. These signals and notifications may include kill signals, notifications that special play modes have been started or stopped, notifications that seeks have been initiated, module or trigger notifications, accelerated version notifications, and other signals or notifications that may be useful in playing back the program. It should be noted that the generation of signals  
10 and notifications may be dependent upon the existence of related conditions. For example, modules and triggers may be flagged to indicate whether notifications relating thereto should be provided to the applications. Generation of signals and notifications may also be conditioned upon whether they occur within a corresponding validity range.

15 The receiver is also configured to generate signals associated with application chaining and to provide the signals to applications in the program. "Chaining" refers to the execution of different applications in the program in relation to each other. The chaining policy defines how execution of certain applications affects other applications. For example, if a first application is currently executing and a second application is  
20 detected and launched, the chaining policy may define whether the first application is terminated or suspended or, if the receiver can concurrently execute both applications, whether they should both be executed at the same time. It should be noted that the capabilities of the receiver may affect the chaining policy, since the policy is implemented in the receiver. (For example, if the receiver can only execute one application at time, the  
25 chaining policy cannot have two applications executing concurrently.)

The signals provided by the receiver to the applications are typically generated sequentially (in the order they would have occurred in a normal playback mode) because the state of an application may depend on the order in which the signals are received.

When the special play mode is a forward mode (e.g., fast forward,) the signals and notifications generated by the receiver are provided to the applications in their normal sequential order. When the special play mode is a reverse mode (e.g., rewind,) the signals may have to be generated in reverse order, or the receiver may have to generate signals which "undo," or reverse the effect of, the forward-play signals.

It should be pointed out that some applications may depend on live data reception to maintain their state. When a special playback mode is used to cause an application to move to a particular point in the playback of the program, precautions may need to be taken to ensure that the application is in the appropriate state after the program returns to a normal playback mode. This needs to be addressed for two different cases: cases in which applications were authored with the intent that they would be recorded and played back; and cases in which applications were not intended to be recorded and replayed.

In the first case, an application is produced with the knowledge that it may be recorded and played back using special play modes. Such an application would typically be designed to accept notifications of these special play modes and to accommodate them. For example, an application can be configured to generate a query to determine the current position in the playback of the program. The application could then set its internal state according to the position in the program.

In the second case, an application is produced with the intent that it will be consumed as it is received. The application is not designed to jump from one position to another in the program except as the program progresses in a normal play mode. If a special play mode is initiated while such an application is executing, the application can simply be terminated and restarted at the new position in the program. The application may be allowed to save information (e.g., state information) to persistent storage such as the storage device when it is terminated. It should be noted that the application may be

removed from memory when it is terminated, so it may have to be downloaded again from the data stream and restarted after the program has jumped to the new position.

Because these two types of applications are handled differently when special play  
5 modes are initiated, it is contemplated that the applications will be configured to indicate to the receiver whether they are capable of handling special play modes. It is also contemplated that some applications may be configured to prevent certain special play modes. For example, an application may be configured to prevent the user from rewinding or may allow the user to rewind only to certain positions, such as the  
10 beginnings of chapters.

While the present invention has been described with reference to particular  
embodiments, it will be understood that the embodiments are illustrative and that the invention scope is not limited to these embodiments. Many variations, modifications,  
15 additions and improvements to the embodiments described are possible. These variations, modifications, additions and improvements may fall within the scope of the invention as detailed within the following claims.